WORKSHOP ON 2nd GENERATION LASER AND PLASMA ACCELERATORS

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Working group 4 Ion acceleration and "all the rest..."

F. Pegoraro

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Abstract

Summary of Working group 4

Four presentations were given [A. Pukhov, F. Pegoraro, T. Katsouleas, E. Esarey], mainly centered on problems related to ion acceleration in relativistic laser pulse interaction with plasmas. High frequency emission was also considered [E. Esarey], but most of the discussion addressed our understanding of ion acceleration in present day experiments and the identification of promising regimes for future analysis and experiments.

1 General Remarks on Ion Acceleration

All the speakers agreed that ion acceleration in ultraintense laser plasma interactions is a fast developing field where a number of fundamental problems are as yet open or at least not fully explored or understood.

In addition it was stressed that this is an extremely promising field in terms of applications: to list a few

- ullet intense (spatially and temporally) localized sources of multi MeV protons $[1,\,2,\,3,\,4]$
 - small-scale fusion reactions [5] (using Deuterons and lower energies)
 - "ion fast ignitor" [6, 7]
 - medical applications [8]
 - proton imaging [9]

It was also stressed that ion acceleration is an interesting field from the point of view of basic physics problems such as

- identify and optimize the different ion acceleration mechanisms (generally mediated through the electrons)
- identify properties to be optimized, maximum energy, collimation, quality of the beam, time resolution, number of particles etc., depending on the specific applications.
- \bullet find proper regimes and setups for selective acceleration of multi-charged ions
 - and more "exotic" particle acceleration.

2 Acceleration mechanisms

Different acceleration mechanisms were presented relevant to different experimental and numerical conditions.

Acceleration mechanisms can be generically divided into two classes (some relevant references are listed)

- 1) quasistationary mechanisms such as
 - # sheath acceleration [10, 11] and
 - # ponderomotive acceleration [12] [A. Pukhov presentation]
 - # snowplough acceleration [T. Katsouleas presentation] [13]
- 2) dynamical (non-adiabatic) mechanisms [F. Pegoraro presentation] [14, 15, 16] # relativistically propagating double layers [14, 15]
- # expansion in vacuum of the electron cloud (+ coulomb explosion of the positive ion charge) [12, 14, 15]
 - # inductive electric field acceleration [15, 17]
 - # charged channel rim acceleration [17]

3 Open questions and goals

- Identification of ion acceleration mechanisms at work in present experiments (thick foils... Petawatt regimes) [1, 2, 3, 11]
- search for different experimental conditions in order to optimize ion acceleration (energy, collimation, beam quality, number of particles) [15]
 - predictions for multi petawatt regimes [11, 15].
- Understanding of beam collimation (which is very important for applications) [15, 7]
 - # magnetic self pinching
 - # geometrical effects
 - # foil deformed by the pulse focuses reflected ions
 - # properly predeformed foil focuses transmitted ions.

4 Theory and simulation needs

Better "quantitative" understanding of the different mechanisms at play and their selective optimization.

3-D simulations with better resolution and more realistic parameters (larger vacuum space to allow for a better simulation of ion acceleration in vacuum

more realistic parameters (in particular plasma density) in the case of the interaction of a pulse with a strongly overdense plasma.

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